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Comparison of two ray tracing methods for sound speed imaging

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Sound speed imaging in USCT is a kind of functional imaging mode which can provide valuable information for differentiating normal tissue and tumor. Sound speed imaging in USCT is a kind of functional imaging mode which can provide valuable information for differentiating normal tissue and tumor. One of the key problems of sound speed reconstruction is ray tracing. This paper compares the sensitivity and the accuracy of the finite difference method and the linear interpolation method.

(2) Material and Methods

Vidale (1988) presented a method that could obtain the first arrival travel times by a finite-difference solution of the eikonal equation. Asakawa (1993) presented a linear interpolation method, which considers a ray path crossing segment AB on a certain cell boundary and reaching point D on the opposite side of the boundary. We use the software pzflex to simulate acoustic-wave propagation in a numerical phantom. A ring array with 72 elements is used. A numerical phantom of four circles with different sound speed value are placed inside the ring array and immersed in water. Then the above two ray tracing methods were compared by the travel times detected in the receiver location and the first-arrival time diagram.

(3) Results

The imaging area is divided into grids firstly. The two methods are used to calculate the first-arrival times in each grid. Both the two methods can "recognize"the two bigger circles with sound speed 2600 m/s .The interpolation method can show the third circle with sound speed value 1579 m/s more accurately. Both of these two method cannot "recognize"the forth circle with sound speed value 1510 m/s. We compared the travel times in receiver position when the sound speed model is true value of the four-circle phantom with the travel times detected in received waveforms. The finite difference method's result is almost the same as the standard, however there is greater error in the interpolation method's result.

(4) Discussion and Conclusion

This paper firstly generated USCT data using software pzflex. Then two ray tracing methods were compared by the travel times detected in the receiver location and the first-arrival time diagram. The comparison came to the conclusion that the sensitivity of the linear interpolation method is higher, while the accuracy of the finite difference method is higher. Theoretically the linear interpolation method is more accurate, the phenomenon probably results from the "expanding wavefront"scheme the finite difference method used, which implies the importance of the expanding scheme used.

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